



**Notable Grand Rounds**  
*of the*

**Michael & Marian Ilitch  
Department of Surgery**

Wayne State University  
School of Medicine

Detroit, Michigan, USA

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**Lawrence Diebel, MD**

**SURGICAL STABILIZATION OF RIB  
FRACTURES: LESSONS FROM HISTORY,  
CASES, AND CONTEMPORARY PRACTICE**

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September 17, 2025

### ***About Notable Grand Rounds***

*These assembled papers are edited transcripts of didactic lectures given by mainly senior residents, but also some distinguished attending and guests, at the Grand Rounds of the Michael and Marian Ilitch Department of Surgery at the Wayne State University School of Medicine.*

*Every week, approximately 50 faculty attending surgeons and surgical residents meet to conduct postmortems on cases that did not go well. That "Mortality and Morbidity" conference is followed immediately by Grand Rounds.*

*This collection is not intended as a scholarly journal, but in a significant way it is a peer reviewed publication by virtue of the fact that every presentation is examined in great detail by those 50 or so surgeons.*

*It serves to honor the presenters for their effort, to potentially serve as first draft for an article for submission to a medical journal, to let residents and potential residents see the high standard achieved by their peers and expected of them, and by no means least, to contribute to better patient care.*

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# Surgical Stabilization of Rib Fractures: Lessons from History, Cases, and Contemporary Practice

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WSU/DMC Grand Rounds

September 17, 2025

*Editor's Note:* This is an edited summary of a Grand Rounds talk given by Dr. Diebel on September 17, 2025 at the Ilitch Department of Surgery, Wayne State University School of Medicine.

## **Introduction**

Surgical stabilization of rib fractures (SSRF) has gone from being a curiosity to a serious option in modern trauma care. For decades, rib fractures were managed non-operatively with the assumption that nature—and time—were the best healers. Yet over the past 25 years, SSRF has steadily moved into mainstream practice, supported by new devices, refined techniques, and a growing body of literature. The rise of societies devoted to chest wall injury and multicenter research has only reinforced this trend.

## **Historical Background**

The history of rib fracture fixation is marked by experimentation, abandonment, and eventual revival. In the early 20th century, pioneers such as Scudder attempted suture cerclage techniques, though these proved mechanically unreliable. By the 1950s, Coleman in Paris introduced plating systems adapted from other orthopedic devices. These included the so-called Judet struts, which clipped onto ribs but frequently dislodged.

The 1970s and 1980s saw further innovation, with investigators like Labitzke and others experimenting with improved struts and

cerclage wires. But it was not until the late 20th century that the development of titanium plating systems made rib fixation both feasible and durable. Since the 2000s, commercially available systems have proliferated, and surgeons now have multiple plating options designed specifically for the chest wall.

This technical evolution has been paralleled by an explosion in published literature. As shown in bibliometric analyses, the number of SSRF-related publications remained sparse until about 2010, after which interest grew dramatically. By 2025, more than two dozen new articles were being published annually, driven by positive outcomes in small randomized controlled trials and improvements in surgical techniques. However, much of the evidence remains retrospective and single-center in nature, underscoring the need for larger, multicenter trials with standardized protocols.

### The Chest Wall Injury Society

One of the most important developments in legitimizing SSRF has been the creation of the Chest Wall Injury Society (CWIS), an international group dedicated to advancing research and education on chest wall trauma. CWIS now publishes consensus statements, guidelines, and position papers, and even devotes entire journal issues to chest wall injury. Membership is open to all comers, but the real significance lies in having a professional body to push the field forward.

### Scoring Systems in Rib Fracture Care

As with many areas of trauma, attempts have been made to reduce the complexity of rib fracture management into numerical scores. Several systems exist—the Chest Trauma Score (CTS), Thorax Trauma Severity Score (TTSS), Rib Fracture Score (RFS), and the Revised Intensity Battle Score (RIBS). These incorporate variables such as patient age, rib fracture count, bilateral fractures, pleural injury, oxygen saturation, chronic lung disease, and neurological status.

On paper, these scoring systems help stratify patients and guide treatment decisions. In practice, however, no score replaces careful bedside judgment. It is more important to look at the patient and at the X-rays.

### Guidelines for Surgical Stabilization

Consensus guidelines have brought more structure to the decision-making process. CWIS issued updated recommendations in 2025 (published in *Journal of Trauma and Acute Care Surgery*), building on earlier joint statements with the World Society of Emergency Surgery (WSES).

### Indications

For ventilated patients, SSRF should be considered in the presence of:

- Three or more bicortical rib fractures with >50% displacement
- Paradoxical chest wall motion
- Significant chest wall deformity (≥20% volume loss)

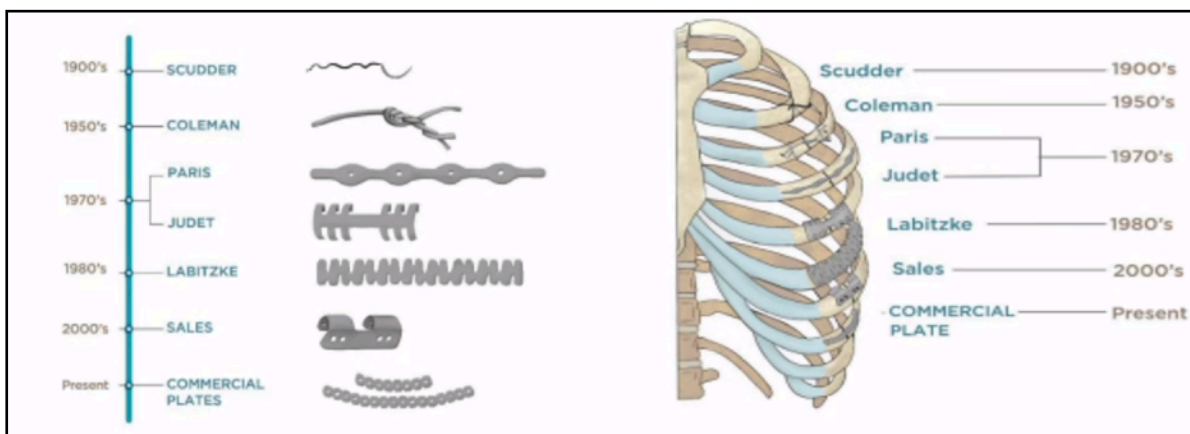


Fig. 1. The History of Surgical Stabilization of Rib Fractures (SSRF). Source: Fig 1 in Shaban, et al, 2022.

- Audible or palpable clicking/popping indicating instability
- Failure to wean from mechanical ventilation due to instability

For non-ventilated patients, the indications are similar, with the addition of:

- Progressive respiratory failure despite multimodal analgesia
- Three or more displaced fractures plus  $\geq 2$  physiologic derangements (respiratory rate  $>20$ , incentive spirometry  $<50\%$  predicted, pain score  $>5/10$ , poor cough)
- Worsening rib fracture severity scores (e.g., SCARF, STUMBL, RibScore)

### Contraindications

Absolute contraindications include hemodynamic instability requiring resuscitation and nonsurvivable brain injury. Relative contraindications extend to pediatric patients, severe traumatic brain injury, unstable spinal fractures, pulmonary contusion, acute cardiac events, and coagulopathy.

### Timing

The “sweet spot” for SSRF is within 72 hours of injury, though clinical realities often delay surgery. That’s not the easiest time, but it’s best for the patient. Fixation can be delayed if higher-priority injuries take precedence, and SSRF can often be safely combined with other surgical procedures.

### The Question of Non-Flail Fractures

While flail chest is an accepted indication, the management of non-flail displaced fractures remains debated. Some studies show equivalent outcomes with and without surgery, while others suggest better results with fixation. A major challenge is the lack of a common language. Recognizing this, CWIS developed a taxonomy of rib fracture displacement (undisplaced, offset, or displaced) and fracture type (simple, wedge, or complex) (see Fig. 2). This framework shifts the discussion from “flail versus non-flail” to a more nuanced classification of injury severity.

### TBI and Severe Trauma Case

One of the most vivid cases involved a 43-year-old male trauma transfer who had collided with a FedEx truck while riding a motorcycle. He presented with multiple rib fractures, a thoracic spine fracture, a scapular fracture, and pulmonary contusions. CT imaging revealed complex posterior fractures with limited bone stock to work with (Fig. 3).

The patient’s course illustrates the challenge of polytrauma sequencing. Five days after admission, once pulmonary contusions stabilized, we performed rib plating on five to six ribs. Roughly a week later, neurosurgery addressed his thoracic spine fractures. He was discharged after 25 days, a relatively good outcome given the severity of his injuries.

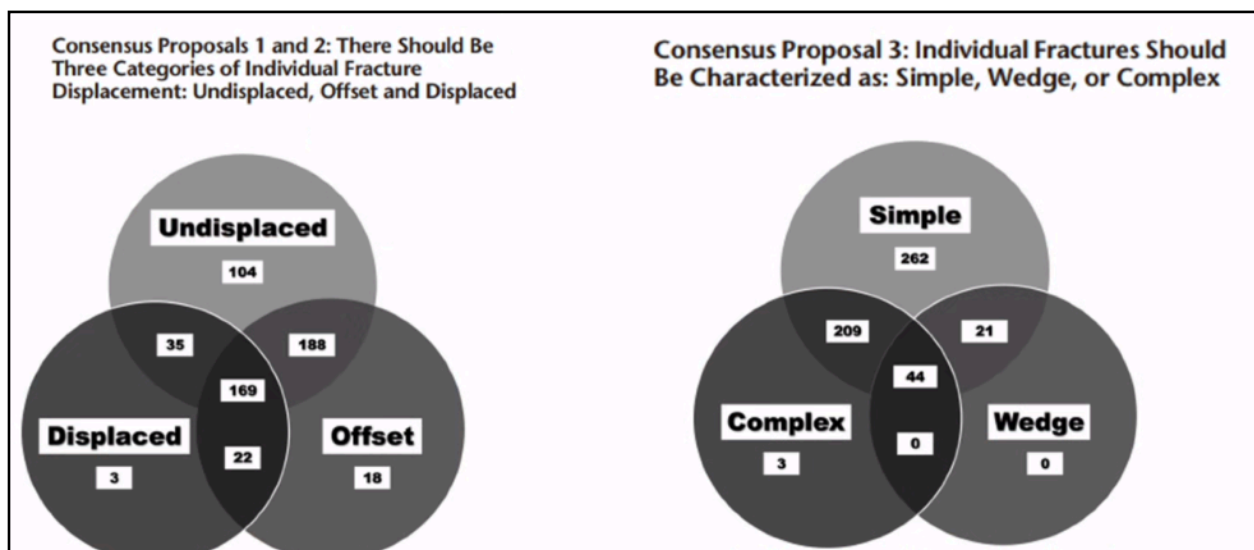


Fig. 2. Society taxonomy for multiple rib fractures. Source: Figs. 1 and 2 in Clarke, et al. (2023).

Anybody that gets run over by a Federal Express truck can't be doing too well. Yet careful coordination across specialties allowed staged management. Importantly, fixing the ribs first enabled lateral positioning without hemodynamic collapse, thereby making subsequent spine surgery safer. This reflects broader lessons from the literature: patients with concomitant major vertebral fractures and multiple rib fractures may require rib fixation prior to prone spinal procedures to prevent cardiopulmonary compromise.

### Rib Fixation in Traumatic Brain Injury (TBI)

Historically, severe TBI was considered a contraindication to SSRF. The concern was twofold: limited survivability and the risk of worsening intracranial pressure. However, new data suggest a nuanced view.

A large CWIS-TBI study (n=456) found that while SSRF did not improve ventilator-free days, it was associated with significantly reduced pneumonia (OR 0.59, p = 0.043) and 30-day mortality (OR 0.32, p = 0.032). In severe TBI patients, SSRF reduced mortality even further (OR 0.19, p = 0.034).

A follow-up analysis comparing flail versus non-flail patterns reinforced these findings:

- In non-flail fracture patterns, SSRF was associated with a lower pneumonia risk (OR 0.29, p = 0.013).
- In flail chest patients, SSRF shortened ICU length of stay (-2.96 days, p = 0.034).

These data support selective fixation even in the TBI population, provided patients have survivable injuries and controlled intracranial pressures.

Not all patients with head injury should have their ribs fixed—but in that 10% or so who are candidates, SSRF can reduce pneumonia and improve survival. Pain management in TBI patients is particularly important, as nociceptive stress can exacerbate hypertension, tachycardia, and storming. SSRF may thus contribute indirectly to neurological stabilization by controlling pain.

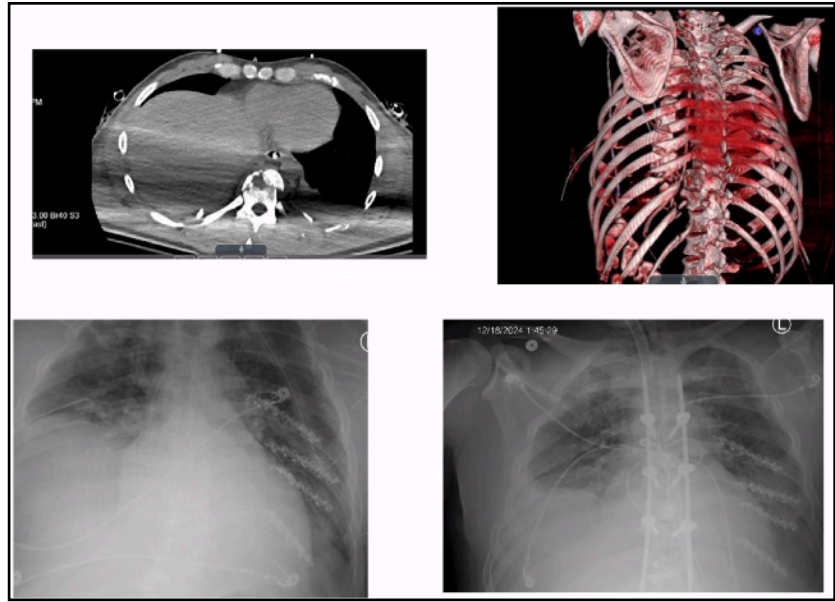


Fig. 3. Motorcycle accident

### Non-Operative Management and Analgesic Strategies

Even with growing enthusiasm for rib plating, the majority of rib fractures are still managed non-operatively. Pain control is the linchpin: inadequate analgesia leads to splinting, atelectasis, pneumonia, and prolonged hospitalizations.

#### Regional Anesthesia

A 2024 review in *Current Anesthesiology Reports* summarized the spectrum of regional techniques for rib fracture pain: serratus anterior plane blocks (SAPB), erector spinae plane blocks (ESPB), intercostal nerve blocks (ICNB), and paravertebral blocks (PVB). Evidence is inconsistent—no single technique has emerged as superior. The Eastern Association for the Surgery of Trauma and CWIS recommended regional anesthesia where feasible, but emphasized that local expertise should guide the choice of block. Whatever works in your institution—if you don't know how to do it, don't bother.

#### Continuous Intercostal Nerve Blockade

One approach with more robust data is the use of continuous intercostal nerve blockade (CINB) with ON-Q catheters. A 2021 Trauma Surgery & Acute Care Open study found CINB improved outcomes in patients with multiple rib fractures,

including increased hospital-free days, more ventilator-free days, and fewer pulmonary complications. The key technical nuance was placing the catheter deeper along a paraspinous plane rather than subcutaneously, achieving broader anesthetic spread.

### *Rhomboid Intercostal and Subserratus Blocks*

Newer techniques such as the rhomboid intercostal and subserratus plane block have also been reported. These require ultrasound guidance but can provide wide anesthetic coverage of the chest wall.

### *Cryoablation: A Promising Adjunct*

Perhaps the most exciting advance is intercostal nerve cryoablation. By applying a probe that freezes the nerve, cryoablation induces Wallerian degeneration while sparing connective tissue sheaths, allowing regeneration at 1–2 mm/day without neuroma formation. The block is temporary but can last weeks, far longer than local anesthetic infusions.

I am an advocate of this approach. Cumbersome older probes leave burns on the skin. Early clinical reports of a new percutaneous, handheld device are encouraging. Forrester et al. described 15 patients with decreased opioid use and pain intensity scores lasting up to 30 days post-discharge. Villalta et al. further demonstrated bedside feasibility with ultrasound-guided percutaneous cryoneurolysis, using the iovera® system, and showing sustained reductions in pain scores.

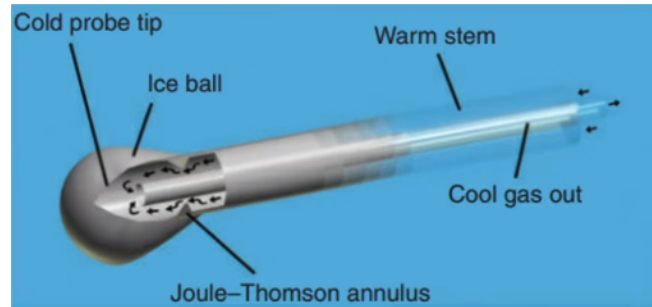
Cryoablation is already being trialed for knee replacement pain and pre-spine surgery analgesia. His institution is considering adoption, supported by leadership familiar with the technology.

## Special Populations

### *Geriatric Patients*

Rib fractures in the elderly remain a formidable challenge. Mortality rises steeply with age, compounded by frailty and comorbidities. Yet recent data suggest that these are precisely the patients who may benefit most from SSRF.

A 2022 analysis of the National Trauma Database identified 93,638 patients ≥65 years old with rib fractures. Only 992 underwent SSRF,



**Fig. 4.** A modern cryoneurolysis probe ('cannula') produces extremely cold temperatures at its tip because of the Joule-Thomson effect resulting from gas flowing from a high- to low-pressure chamber. *Source:* Fig. 1 in Ilfeld et al. (2017)

yet among those aged 65–79, surgical fixation was associated with improved survival regardless of the number of fractured ribs. Other studies have echoed this finding: early fixation (within 72 hours) results in better outcomes than late intervention, including lower complication rates, fewer ventilator days, and shorter ICU stays.

Frailty, not age alone, should guide surgical decision-making. The frailty index is important in evaluating geriatric trauma patients.

One illustrative case involved a 79-year-old man who fell off his roof while trying to remove a satellite dish after his cable was cut. He sustained right-sided rib fractures with a flail segment. Following rib plating (ribs 3–5, 8–11), he was discharged in 16 days to subacute rehab. His outcome underscored both the technical feasibility and functional benefits of SSRF in elderly patients when carefully selected.

## Pulmonary Contusions

The presence of pulmonary contusion complicates decisions around SSRF. Mild contusions are not a contraindication and may even improve outcomes with rib fixation. A Dutch study of 221 patients showed that in those with mild contusions, SSRF shortened ICU stay, while in moderate contusions it reduced ventilator days. However, in severe contusions, outcomes did not differ between operative and nonoperative management.

A complementary case series reported by Tumminello et al. highlighted risks when SSRF was performed early in patients with contusion volumes >20% on CT. Several patients

developed postoperative ARDS, often related to aspiration during intraoperative positioning. The authors recommended delaying SSRF or using selective lung isolation when operating on such patients.

I recall one case vividly: a heavy-set motorcycle crash victim with severe contusions who deteriorated when placed on his side for rib fixation. Despite tracheostomy and supportive care, he succumbed to sepsis and a missed cardiac event. Not all contusions are created equal. Mild contusions you can fix. Severe contusions should make you pause.

### Rib Fixation After CPR

Rib fractures after cardiopulmonary resuscitation (CPR) are common—CT studies show rib fractures in 65–70% of patients and sternal fractures in 8–30%. These injuries often create anterior flail segments, with paradoxical motion exacerbating respiratory distress.

Several international studies have evaluated SSRF in CPR survivors. A matched case-control analysis of 105 patients (39 SSRF vs. 66 nonoperative) found that SSRF was performed at a median of five days post-arrest. While ICU length of stay was longer in the SSRF group, mortality and major complications were similar, suggesting SSRF is safe in selected cases.

An 84-year-old man collapsed after a meal with his family. Following brief bystander CPR, he arrived in the resuscitation bay awake but struggling to breathe. Imaging revealed an anterior flail chest with multiple cartilage and sternal disruptions. Despite rib plating with four plates, he later suffered respiratory decline. His family—aware of his advanced comorbidities (COPD, prostate cancer, prior lung cancer)—withdrew care after 36 hours.

Some people said I should have done nothing for him. But if you had seen him breathing, I don't think anyone with a conscience could have left him like that.

### Complex and Unusual Cases

#### *Chest Wall Destruction and Bioabsorbable Plates*

Not all rib fractures can be addressed with standard titanium plates. One patient presented with a self-inflicted shotgun wound that

destroyed a large portion of the anterior chest wall. In such circumstances, plating requires improvisation. Bioabsorbable plates, stacked and sutured together, were used to bridge across the defect. Vertical plates anchored the construct to adjacent ribs, creating enough stability for chest wall reconstruction with available soft tissue coverage.

Though the patient ultimately did not survive, the case demonstrates the adaptability of SSRF principles beyond conventional fracture fixation. These techniques overlap with reconstructive surgery, underscoring the need for multidisciplinary collaboration in extreme trauma.

#### *Cartilage Plating in Flail Chest*

Another area of innovation is the fixation of costal cartilage fractures, which can contribute to anterior flail segments. Surgeons from OhioHealth and Mount Carmel reported using a submammary incision with pectoralis dissection to expose costal cartilage and sternum. Screws were placed into ribs, cartilage, and sternum, with typically three screws per side. This allowed fixation of otherwise unstable anterior segments that standard rib plates could not adequately control.

#### *CPR-Related Anterior Flail*

Anterior flail segments caused by CPR pose unique challenges. CT reconstructions reveal a characteristic pattern of fractures at ribs 3–5, often with sternal disruption. These injuries create paradoxical chest wall motion that magnifies respiratory compromise. Studies from CWIS have proposed algorithms for managing such patients, emphasizing neurological recovery and overall prognosis before proceeding with fixation.

#### *Positioning Hazards in Polytrauma*

In patients with concomitant spinal and rib fractures, surgical positioning itself can be hazardous. A 2019 study in *Journal of Orthopaedic Trauma* reported that 4 of 57 polytrauma patients with major vertebral fractures and rib instability had operations aborted due to cardiopulmonary collapse in the prone position. For these patients, rib fixation prior to spine surgery may stabilize the chest wall enough to allow safe prone positioning.

## Emerging Directions in SSRF

The field continues to evolve, with several promising directions:

- **Expanded Indications:** Evidence now supports SSRF in select patients with TBI, geriatric trauma, and non-flail fracture patterns, challenging earlier dogma.
- **Adjunct Analgesia:** Cryoablation and continuous catheter techniques may reduce pain and complications, extending the benefits of SSRF beyond stabilization alone.
- **Material Science:** The use of titanium remains standard, but bioabsorbable constructs and cartilage fixation expand the toolkit for complex cases.
- **Timing:** Across multiple studies, early fixation (<72 hours) consistently shows better outcomes than delayed intervention.
- **Guideline Harmonization:** CWIS and WSES position papers have created a framework for indications, contraindications, and timing,

though more multicenter prospective studies are still needed.

## Conclusion

Surgical stabilization of rib fractures has matured from a fringe procedure to a cornerstone of modern chest wall trauma management. The evidence base, though still evolving, demonstrates clear benefits in select populations: reduced pneumonia, shorter ICU stays, and improved survival.

The key is patient selection. Not all fractures need plating, and not all patients are candidates. But for those with flail segments, severe displacement, refractory pain, or physiologic decline, SSRF offers a tangible survival advantage. With ongoing refinement of techniques, adoption of adjunctive analgesia, and expansion of training, SSRF is poised to become a standard part of trauma surgery worldwide.

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